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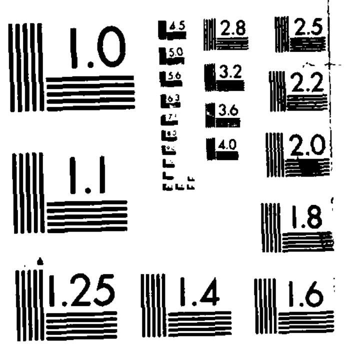

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AD-A161 728

THE EFFECT OF A COLD CLIMATE ENVIRONMENT UPON THE PERFORMANCE OF MISSILE MAINTENANCE AND SECURITY POLICE ORGANIZATIONS

THESIS

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AFIT/GLM/LSMA/85S-77

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THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

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John D. Thomas, B.S.

Captain, USAF

September 1985

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Abstract

This investigation determined the effect of cold temperature variations on the performance of security police and missile maintenance organizations within Strategic Air Command (SAC). The security police performance measurement was based on the rating given to each organization by the SAC Inspector General observing the execution of a Major Accident Response Exercise (MARE). Missile maintenance performance was based on the rating the organization received from the annual Strategic Missile Evaluation Squadron (SMES) inspection. The missile maintenance organization was observed performing routine maintenance tasks. For each security police and missile maintenance performance rating, the temperature at the time of the observation was obtained from the National Weather Service.

Simple linear regression was used to determine the strength of correlation between the temperature at the time of the evaluation and the performance rating received. By using simple linear regression it was possible to determine if performance declined as the temperature became colder. The results of this investigation revealed that no correlation existed between the observed temperatures and the performance ratings received by the sampled units.

THE EFFECT OF A COLD CLIMATE ENVIRONMENT UPON THE PERFORMANCE OF MISSILE MAINTENANCE AND SECURITY POLICE ORGANIZATIONS

I. Introduction

General Issue

Many United States Air Force bases are located in regions experiencing long, harsh winters. As such, personnel assigned to these bases must perform their duties under extreme environmental conditions. Since many of these duties are essential to national defense, it is imperative that the impact cold weather environments have upon the performance of those duties be evaluated.

Strategic Air Command (SAC) operates missile, air refueling, and bomber wings in cold climates. For example, nuclear bomber and air refueling wings are located at Grand Forks and Minot, North Dakota as well as at Loring, Maine; Pease, New Hampshire; and Plattsburg in northern New York (30:2-3). Also, nuclear missile wings are located at Grand Forks and Minot, North Dakota with other missile bases at Rapid City, South Dakota; Great Falls, Montana; and Cheyenne, Wyoming. (30:2-3). With such a large portion of this nation's nuclear defenses situated in cold climatic conditions, it is crucial to understand exactly how the climate affects the readiness of strategic forces. Through this understanding efforts can be made to improve the readiness of the strategic forces based in cold climates.

Various functions are performed at all SAC bases supporting these strategic weapon systems. Such functions as aircraft maintenance, missile maintenance, security police operations, civil engineering, and fuels management are performed with personnel largely exposed to the environment. Since the performance of these functions sustain the readiness of the weapon systems, it is important to determine if these duties are hampered by cold weather operations. This investigation will concentrate on the effect of cold temperatures on selected support functions.

Definitions

Cold climate: Three distinct climatic categories fall into the general label of cold climate. These categories include frigid climate, subarctic, and artic. To qualify as a cold climate, a geographical region must have as a minimum of 3 to 5 months annually with a monthly temperature of 32 degrees or lower (17:10).

Effectiveness: the act of producing a desired result or achieving a predetermined objective. Effectiveness can be measured in terms of the degree to which the objective sought was accomplished (10:248).

Readiness: the state in which a system is immediately capable of performing its prescribed function without repair or nonroutine input (12:12). Synonym: Fully Mission Capable.

Literature Review

This literature review will begin by explaining the relationship between stress and cold weather exposure. Afterwards, a review of past studies conducted with regard to cold climate exposure will be noted.

Stress is defined by Raymond Novaco as a condition of imbalance between environmental demands and the individual's inner resources for coping with those environmental demands (28:379). Stress causes psychological and behavioral reactions in the individual, with the degree of reaction depending upon the extent of the imbalance between self and environment (28:393). Once stress is encountered by the individual, two eventual outcomes are possible: 1) the individual will adapt to the stress by practicing stress reduction behavior, or 2) the individual will attempt to escape from the stress by practicing stress avoidance behavior (28:393). When stress escape is not possible, deviant behavior is the immediate result (28:394). This deviant behavior can be displayed in many forms such as changes in personality, emotional venting, or mental incongruencies like forgetfulness, apathy or lack of the ability to concentrate (28:394).

Irwin Sarason notes that the physical setting or climate can be a direct cause of stress (31:6). Environmental incongruence is the result of an individual's inability to cope with their environment (31:36). However, their inability to cope with the environment may be a more perceived inability than an actual inability (31:36). Therefore, there may be mental incongruence where environmental incongruence does not actually exist (31:36). This is an important point since it is more appropriate to focus upon mental incongruence rather than environmental incongruence as a contributor towards stress since stress is only possible where perceived incongruencies exist (31:36).

The cold of winter is considered an extreme condition to those individuals not adapted to it (9:30). Adaptation to the cold can be augmented to a great extent by wearing protective clothing and gear; however, all individuals are vulnerable to the effects of cold to varying extents depending upon personal experience and abilities (9:31). Depending on the extent to which individuals are adapted to the cold, their level of stress becomes a greater concern in producing deviant behavior (9:31).

Mel'nikov conducted studies of Russian grade school children exposed to varying degrees of cold temperatures while undergoing vigorous exercise. In all, approximately 7740 children were tested and observed to determine the effects of prolonged exposure to severe cold temperatures outdoors (26:8). His studies reveal that while physical problems such as frostbite and body temperature drops of approximately 1 degree or less were common, the emotional mood of the observed children was good (26:7-8). Mel'nikov discovered that as the outdoor exercise was continued on a regular basis in the cold climate, the children began to adapt with a decrease in blood pressure and increased oxygen consumption capacity (26:6). Running times among the tested children for the 30 meter run improved as did distances for the standing long jump and the standing high jump (26:6). Mel'nikov's experiments provide evidence of physical adaptation to the cold by progressive intervals of exposure to the cold while engaged in exercise.

Another Russian study headed by N. I. Bobrov notes similar initial difficulties among individuals upon exposure to cold climates. Bobrov observed general disorders such as "heightened tiring, sleepiness, dizziness, poor appetite, headaches, and body pains" (5:151). Bobrov also found that some symptoms such as irritability, insomnia, and headaches, are more predominant during day hours, while sleepiness, inhibition, and reduced efficiency were common at night (5:151).

During periods of acute stress, there is an increase in "the production of sugar in the blood, which can, in turn, lead to a strengthening of the body's production of insulin" (29:119). "This process provides the individual with an energy safeguard to support its internal physiological functions of organs" (29:120). However, it is not certain how such processes work or how they are altered when exposure to extreme environmental cold is encountered

(29:120). Panin concludes that when a stressful situation is encountered by an individual not adapted to a cold climate, the reaction is not predictable (29:120). Consequently, human reliability is questionable in stressful situations where a nonacclimatized individual is involved (29:120). Bernard Fine and John Kobrick conducted studies on human performance under climatic stress and discovered that it is fallacy to attempt to define an "average person" with regard to ability to perform in adverse weather conditions (20:1). The implication that "all military personnel can perform all tasks equally well under all conditions is false... individual differences must be accounted for", (20:1). At best, "climatic stress will adversely affect some of the people some of the time in performance of duty" (20:2).

Dr. Yu Sten'ko in his study of personnel under extreme environmental conditions noted that there are various rates at which individuals adapt to cold climates (32:1). Furthermore, much of the climatic stress an individual feels is based on their own body's reaction to the cold and is not entirely psychological in nature (32:1-2). For this reason, predicting individual reaction to the process of adjustment to the cold is difficult (32:2). Through Dr. Sten'ko's studies of groups of men adapting to cold weather environments, he concludes that organizational behavior will follow a pattern characteristic of the composite of the individuals (32:1-3).

Problem Statement

To maintain maximum force readiness, the Air Force needs to know if cold temperatures decrease organizational performance for units supporting weapon systems.

Research Objectives

Previous reasearch has demonstrated that cold weather can be a significant cause of deviant behavior among individuals. Many factors can cause this deviant behavior. Among these causes are environmental incongruence, poor adaptation, physical activity level, and individual physiology. Deviant behavior can be physical as well as mental in nature. Research by Bobrov, and Sarason indicates that mental abilities can be significantly degraded in cold temperature environments. Since cold environments can affect both the physical and mental performance of individuals exposed to it, research should evaluate tasks requiring a high degree of mental concentration and as a contrast, tasks not requiring a high degree of mental concentration in cold environments.

The studies conducted by Fine and Kobrick indicate that problems are associated with assuming organizational performance to be the composite or average of individual performances. Since individual differences exist, it is possible that organizational differences may also exist.

Because the relationship between cold weather and organizational performance has not been established, this research shall consequently focus on the relationship between adverse temperatures and organizational performance for Air Force units performing technical and nontechnical tasks. Specifically, the objectives of this research are to:

1). Determine if a relationship between organizational performance involving nontechnical tasks and cold temperature exists.

2). Determine if a relationship between organizational performance involving technical tasks and cold temperature exists.

3). If a relationship between temperature and performance exists, determine the strength of the relationship.

Test Hypothesis

Ho: As the temperature decreases, the level of performance by an organization will decrease.

Ha: As the temperature decreases, the level of performance by an organization will not decrease.

Scope

The objective of this study is to determine if organizational performance declines as the temperature becomes colder. To generate a data base for statistical testing of this hypothesis, the organizations choosen for sampling must be evaluated in a standardized manner by a common evaluator. The organizations selected as a representative support function of a technical nature are SAC Minuteman missile maintenance teams performing tasks at missile launch sites. Representing support functions of a nontechnical nature are security police squadron law enforcement branches operating in SAC. Minuteman missile maintenance squadrons were selected for analysis since these units perform many maintenance tasks exposed to cold climate environments, have a common task description, and are evaluated by the same team using identical evaluation criteria. Similarly, security police law enforcement personnel within SAC were examined because they accomplish their duties exposed to cold climates, perform required tasks under a uniform set of guidelines, and are evaluated by a central team using standard evaluation criteria. By sampling both missile maintenance teams and law enforcement branches, a comparison can be made in organizational performance between technical and nontechnical duties with respect to cold climates. Both the missile maintenance and security organizations represent a sample of the many Air Force units facing cold weather conditions.

Performance by missile maintenance organizations will be examined using performance ratings received during inspections from the 3901 Strategic Missile Evaluation Squadron at Vandenburg AFB, California. The 3901 SMES annually evaluates each of the six Minuteman maintenance organizations (Ellsworth, F.E. Warren, Grand Forks, Malmstrom, Minot and Whiteman AFBs) and records the unit's orgainzational performance through the use of pass/failure rates. The SAC Inspector General security evaluation team an-nually observes each security police squadron's law enforcement branch and records the unit's performance in executing a Major Accident Response Exercise. The IG assigns a rating to each law enforcement branch based on their performance of the exercise. A more detailed description these tasks is presented in Chapter II.

Background

Missile Maintenance Environment. While no formal study has been performed addressing the problems encountered by security personnel in cold climates, a 1984 study by the Air Force Human Resources Laboratory interviewed 70 missile maintenance personnel regarding the problems of warm clothing and protective equipment (11:69). The most common problems voiced by those interviewed included inadequate winter clothing, poor heating in crew vehicles, and poor quality equipment for removing snow at missile sites (11:70). The clothing provided to missile maintenance personnel was considered to be too bulky to permit adequate freedom of movement while performing maintenance tasks (11:70). Current winter gear issued to missile maintenance personnel consists of a heavy parka which allows the cold air to blow up the wearer's back when he or she is bending over performing maintenance (11:70). This same problem was noted by MSgt Art Avant, an Air Force maintenance supervisor with over 9 years of experience in missile maintenance in cold climate environments (3). MSgt Avent also explained that the cold climate became a greater physical difficulty among the maintenance personnel over 30 years old than among the younger ones (3). MSgt Keller, a missile maintenance evaluator with field experience at every cold climate missile base in SAC discussed some of the particular problems he noted among missile maintenance personnel working in the cold. MSgt Keller said that the newer maintenance personnel try to take short cuts when performing tasks in order to leave the cold faster; however, the more experienced personnel realize that spending a little extra time and doing the tasks right will prevent their having to go back out the missile site the next day to correct the problem again (23). Nevertheless, in MSgt Avent and MSgt Keller's opinion, attention to detail in task performance is degraded and quality workmanship is negatively affected when maintenance is performed in cold environments (23). MSgt Robert Burge, another seasoned maintenance supervisor, felt that not only was the quality of work lower in extremely cold climates, but that the use of required safety equipment also becomes minimal (8). In addition, maintenance personnel are less likely to notice malfunctions with their equipment or with the weapon system when they are cold (23). MSgt Burge felt that this was largely due to the "hurry up and finish so we can go home" attitude (8).

With the deactivation of the Titan II missile forces in Arizona, Kansas, and Arkansas, all of this nation's strategic nuclear missile wings will be located in cold climates except for Whiteman Air Force Base in Missouri (24:7). Since the nuclear missile forces make up a key element in the United States' nuclear defense triad, (the triad being composed of nuclear strike components from bomber, missile, and submarine forces), it is vital to determine if their cold climate basing affects their readiness.

The readiness of missile forces depends on both the con-dition of the missile and associated equipment as well as the performance of those personnel supporting the weapon system (12:12). Since the missile system was designed to operate in a cold climate and has integrated controls to maintain constant atmospheric conditions suitable to its operation, the effects of cold climatic conditions upon missile readiness will be more pronounced upon the personnel assigned to support the system (27:21-23). Consequently, this paper will focus upon the human factor.

The primary duties directly contributing to a missile system's readiness include missile crew operations and missile maintenance (1:5-6). However, since the missile crew performs its duties beneath the ground in a climate controlled capsule, adverse weather conditions do not directly impact their normal performance of duty (27:21). On the other hand, maintenance teams that must work exposed to the outside environment are immediately exposed to harsh climatic conditions (1:5). Moreover, the degree to which maintenance personnel perform their duties correctly and rapidly is a significant factor towards determining missile readiness (24:299).

The Minuteman II and Minuteman III missile systems comprise over 95% of SAC Inter-Continental Ballistic Missile (ICBM) forces (30:2-3). The remaining 05% of SAC ICBM forces are composed of Titan II missiles which are currently being deactivated. The bases operating these Minuteman missile systems include Minot AFB, North Dakota; Grand Forks AFB, North Dakota; Malmstrom AFB, Montana; Ellsworth AFB, South Dakota; Francis E. Warren AFB, Wyoming; and Whiteman AFB, Missouri (30:2-3). As noted before, with the exception of Whiteman AFB, all the strategic missile wings are situated in cold weather climates. While the crew monitoring the missiles is housed within climate controlled capsules 50 feet below the surface of the ground (see Figure 1), the missiles controlled by the crew members are located

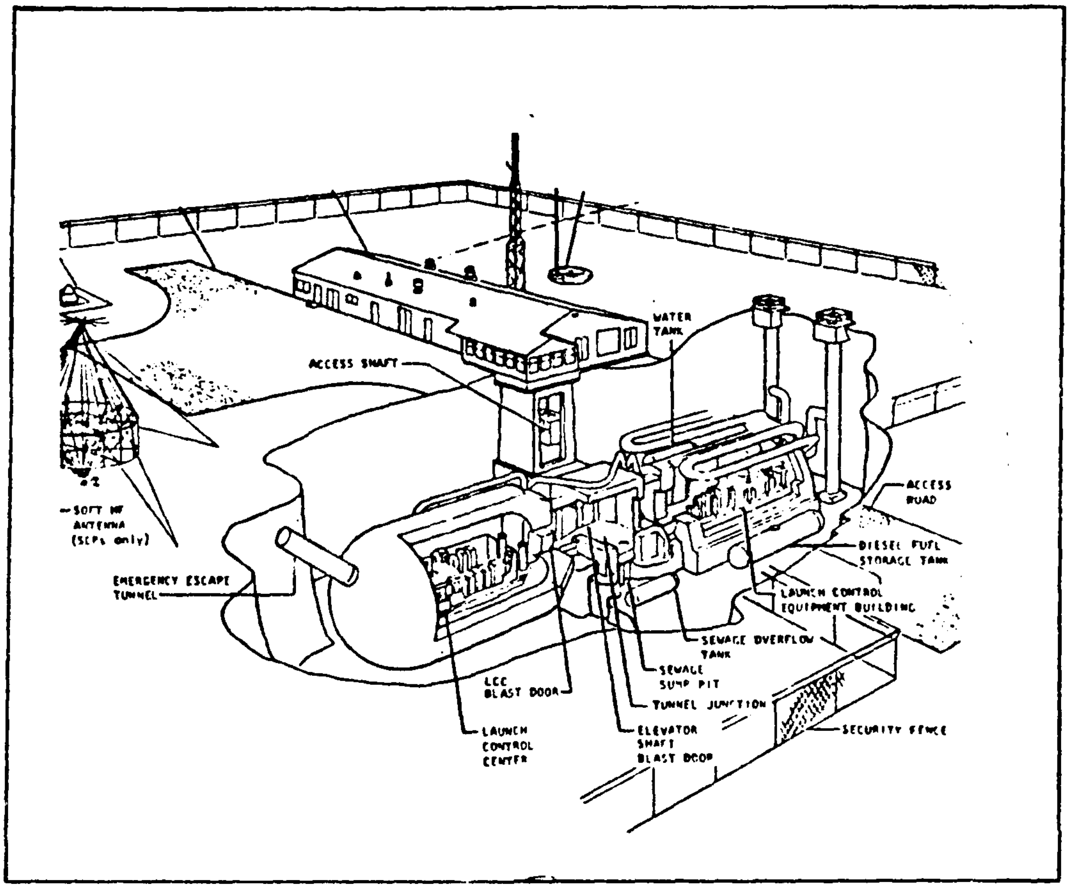

Figure 1. Minuteman Launch Control Capsule

miles away in separate, hardened silos (see Figure 2), (27:21-23). The missile is contained within a launcher tube and can be accessed via an entry hatch or by opening the silo closure door. Maintenance personnel working on the missile with the silo door open or working on above ground support equipment are exposed to the prevailing climatic conditions until the maintenance task is complete or until the silo door is closed (27:21-23).

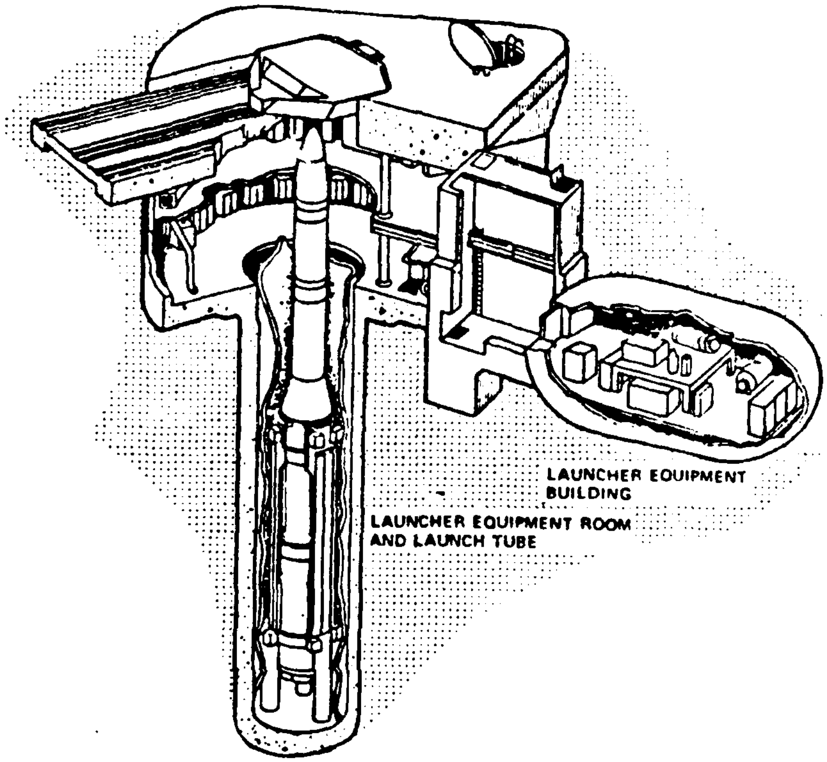

Figure 2. Minuteman Missile Launch Silo

Not all missile maintenance personnel are accustomed to cold climate temperatures. Missile personnel enter the missile career field with varying backgrounds and from all states in the country (27:9). The only common thread in each missileman's background is a past history of personal reliability (27:13). Such items as personal health, mental attitude, and personality disorders are screened by the Department of Defense (DOD) to ensure that personnel assigned to vital duties with nuclear missile systems have the highest reliability (27:13). As such, personnel performing missile functions directly affecting weapon system readiness are assumed to be responsible and motivated individuals (24:14). Personnel selected for missile maintenance duties receive specialized training at Chanute AFB, Illinois (13:1). In fact, standardized training is given to all missile maintenance personnel transferring into or within the career field (13:4). Emphasis is placed upon accomplishing duties exactly in accordance to prescribed technical specifications since there is "no room for mistakes" when dealing with the operation or maintenance of nuclear weapons (6:12-13). Consequently, there is great pressure upon missile personnel to perform at high levels of competence without error. Such pressure translates into stress upon the individual.

Missile maintenance personnel are organized into two squadrons; the Organizational Maintenance Squadron (OMS) and the Field Maintenance Squadron (FMS) (See Figure 3). These squadrons provide missile maintenance teams for on-site equipment repair and general maintenance (18:7,17).

The units within the OMS and the FMS to be used as the sample population will be the Electro-mechanical teams

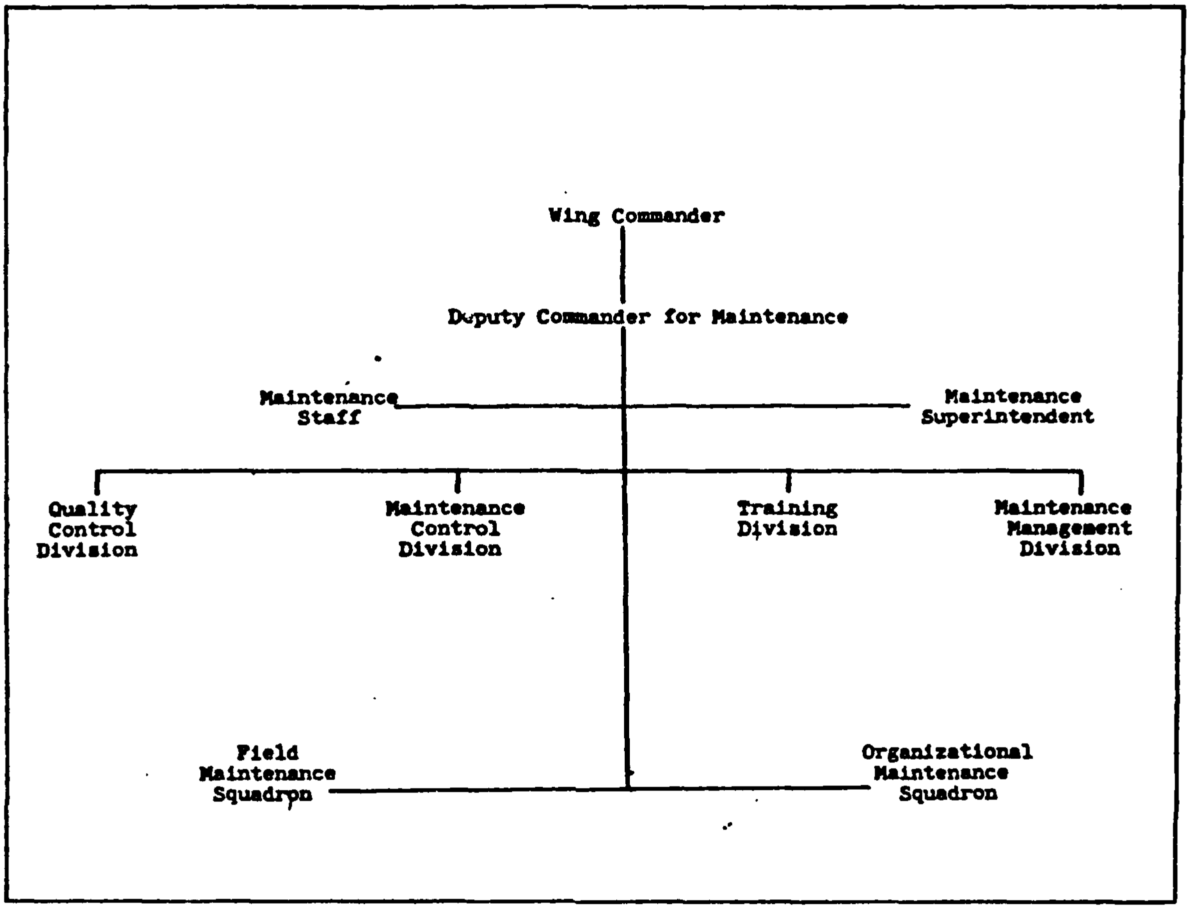

Figure 3. Missile Maintenance Organizational Structure (Wing Level)

(EMT), Corrosion Control teams (CCT), Missile Handling teams (MHT), Missile Maintenance teams (MMT), and the Periodic Maintenance teams (PMT). These teams are the basic subunits which collectively form the OMS and FMS within each missile maintenance organization.

The maintenance units within the OMS and FMS perform various task functions supporting the Minuteman missile system. The EMT perform maintenance and upkeep of missile electronic racks which provide missile alignment, and also perform maintenance on above ground electronic security surveilance systems (3). CCT inspects the missile and associated support equipment and facilities for surface deterioration and removes and prevents surface corrosion of equipment (3). The MHT primary responsiblity is to perform all missile transfer and installation procedures both at the missile site and at the on base maintenance facility (3). MMT duties include ordnance removal and replacement procedures as well as removal and replacement of missile system linkage to the launch silo (3). PMT is responsible for conducting inspections of the entire missile system and support equipment at prescheduled intervals (3). Except for the CCT, exposure to the cold during maintenance performance is approximately the same for all the teams (3).

Security Police Environment. In addition to the technical tasks performed by missile maintenance personnel, it is desirable to examine the effects of a cold climate environment upon task performance of a nontechnical nature. In this way, a contrast can be drawn between the effects of a cold climate environment upon technical vs. nontechnical tasks. Security personnel are present at all SAC bases and perform tasks of a nontechnical nature. Their primary mission is to provide security and protection from hostile elements threatening missile, aircraft and base operations (22).

Providing security for aircraft operations involves the physical presence of guards watching the aircraft and surrounding flight line areas for signs of intrusion or hostile activity. While on guard, the security sentry is completely exposed to all climatic conditions. Missile security sentries also must stand guard at missile sites exposed to the climate. Base security personnel when performing base accident response duties must patrol the accident scene and are exposed to the climate for the duration of the accident response (22).

The Security Police Squadron (See Figure 4) is composed of various functional subunits depending on its mission. Every security squadron will include as a minimum a Law Enforcement Branch (16: 43-76). Also, Missile Security and Aircraft Security Branches will be assigned to the squadron if the mission requires their use (16: 43-76). The Law Enforcement Branch is tasked with providing security and law enforcement services to the base support facilities, base housing, and all aspects of the base not protected by specialized security forces (14:5-6). The Law Enforcement Branch is also responsible for the safe evacuation of personnel from areas affected by dangerous accidents or mishaps such as toxic leaks, explosive detonations, terrorist or armed suspect activity, and natural disaster hazards such as tornados or fire (14:5-6).

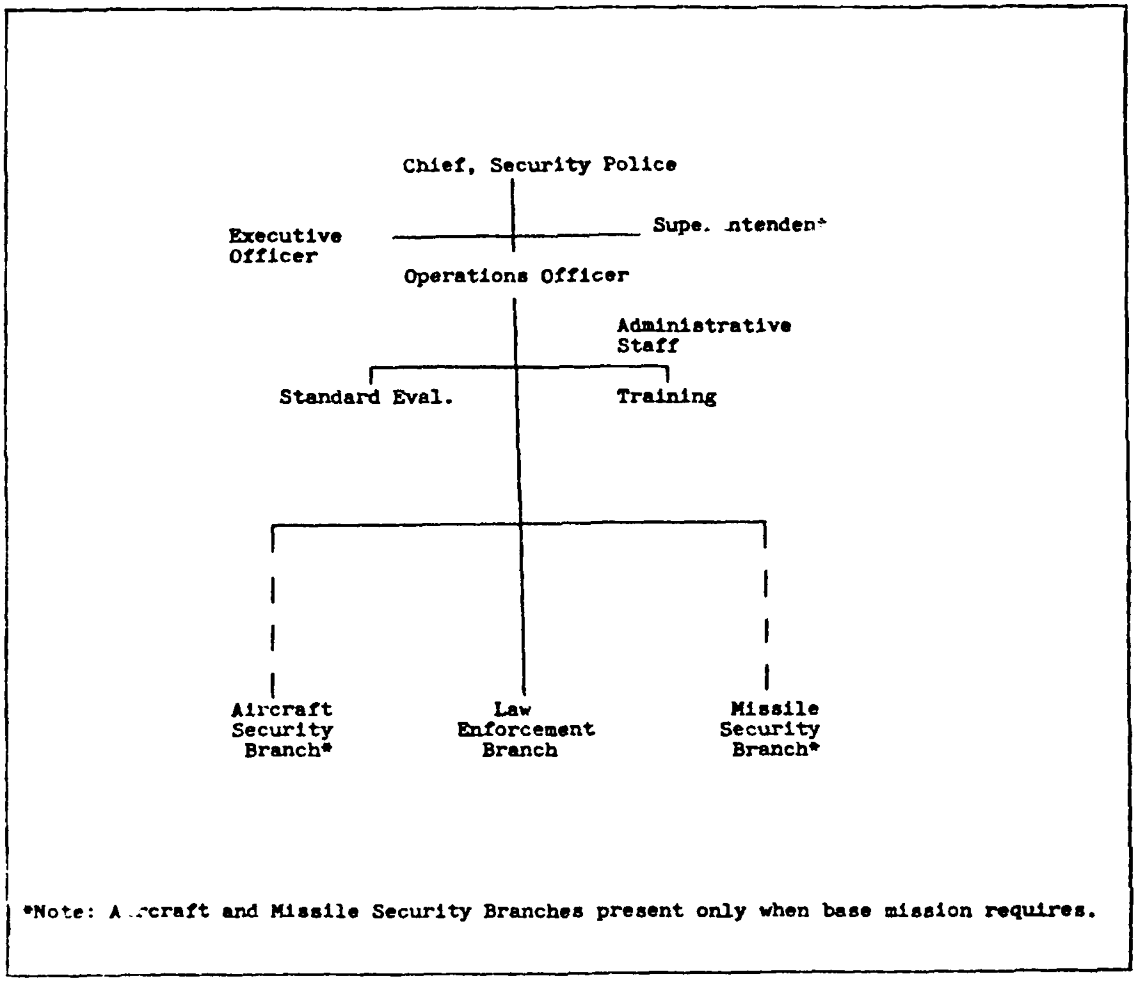

Figure 4. Security Police Squadron Organizational Structure

Missile Security responsibilities apply whenever an active missile unit is located at the base and requires security forces to safeguard weapons and associated weapon systems. Duties of Missile Security forces include responding to intruder alarm activations, investigating suspected and actual intrusions or deviations in routine procedure which indicate possible intrusion, and providing sentries to guard missiles when required (15:1-15).

Aircraft Security forces protect bomber and refueling tanker aircraft if located at the base. These security forces maintain a 24 hour security vigil around such alert aircraft allowing no one to enter the aircraft parking area without prior authorization (14:1).

Summary

Cold weather conditions can be a significant cause of stress. Stress, in turn, has been found to be capable of reducing mental abilities as a result of lowering individual levels of concentration, while increasing apathy and forgetfulness. Because the critical nature of missile related duties requires high levels of mental cognizance in order to perform specialized technical tasks without error, reduced mental abilities due to cold weather conditions may have a direct, negative effect upon the ability of missile maintenance personnel to perform their duties as effectively as they would under less extreme weather conditions. With the rise of antinuclear weapon protests and increased terrorism, the importance of securing nuclear weapon operations has become a significant support function. Therefore, it is desirable to determine the impact of cold weather on the performance of security personnel involved in this important, nontechnical task.

Although existing research demonstrates that individual performance can become degraded due to cold weather environments, the relationship of reduced performance to organizational behavior has not been clearly established. The research conducted will focus on the performance of selected Air Force organizations operating in cold climate environments.

II. Methodology

Introduction

This chapter outlines the method used to test the hypothesis that cold weather degrades task performance. First the purpose of the methodology will be discussed. Next, the population sampling proceedure is explained in order to provide an understanding of why the organizations selected for evaluation were used. A discussion of the statistical procedure used to test the hypothesis is presented with emphasis on highlighting the mathematical procedure used to determine correlation strength between variables. Finally, the limitations of the methodology and statistical model are explained with the implications on research validity discussed.

Methodology Objective

The primary objective of the methodology is to determine if organizational performance varies as temperature decreases. Accomplishing this objective will require the comparision of selected performance samples against the temperature at the time of performance and testing for correlation in variance. To accomplish this, the methodology must specifically:

1). Select population sample data for use in testing the null hypothesis.

2). Select the statistical method for determining if there is a relationship between organizational performance and temperature variation for the sampled population.

3). Determine the strength of correlation between organizational performance and temperature variation.

Population Definition

In selecting the Air Force organizations used to generate population samples, the following guidelines were established.

The selected organizations must:

1) perform their duties exposed to the cold temperatures
2) perform duties which are evaluated objectively by an external agency on a regular basis
3) perform duties which are standardized for all similar organizations

The two organizations selected for evaluation as representative of technical task performers were CCT, MMT, PMT, EMT, and MHT maintenance teams in SAC Minuteman missile maintenance squadrons, while nontechnical task performers were represented by law enforcement branches within SAC security police squadrons (SPS).

Evaluation Procedures

The 3901 SMES evaluates each missile wing yearly (3). Within the OMS and FMS, units are evaluted performing tasks peculiar to their functional responsibilities. For example, the EMT is evaluated performing maintenance tasks on the missile's electronic racks and on electronic security surveilance systems (3). The evaluator watches as the team performs the maintenance and inspects for conformance to correct procedure as directed in technical manuals, conformance to applicable safety standards, and completeness of maintenance performed (3). The 3901 SMES records the pass rate for the given tasks based on the percentage of individuals passing the evaluation against the total number of individuals evaluated. For example if 10 personnel are evaluated and 5 pass, then the pass rate is 50%. The numerical pass rate (0 - 100%) will be used as inputs to the statistical methodology determining temperature/performance correlation.

All SAC SPSs are evaluated at least once every 18 months by the SAC IG (7). All SAC bases do not have missile or aircraft security responsibilities; as such, these two security responsibilities were not used as population samples. However, all SAC bases have a Law Enforcement Branch. The security task evaluated by the SAC Inspector General which is common to all SAC Law Enforcement Branches is the performance of the Major Accident Response Exercise

(MARE). The MARE is a combination of several tasks including response to a simulated major accident on the base; isolating, containing, and cordoning the accident site; and finally evacuating personnel from the accident (22). Throughout the duration of the exercise, which lasts from one to three hours, security personnel are constantly exposed to the climate (22). The overall rating given to each SPS for their performance on the MARE is an average of the individual scores received on each of the three previously mentioned parts of the MARE (22). The final score will be a value between 0 and 4.0 with 0 being an unsatisfactory score while 4.0 designating a perfect score (22). At the initiation of the exercise the SPS begins with a perfect 4.0 score. Each time an error is made by the unit in performing the exercise, the evaluator deducts 0.1 for a minor error and 1.0 for a major error (22). A minor error is a nonsignificant deviation from standardized procedure while a major error is a deviation which causes injury or death to personnel or causes serious loss or damage to equipment and facilities (22).

The MARE provides an excellent task for population sampling for two reasons. First, security personnel are exposed to the climate while performing the task and second, MARE execution and evaluation is standardized throughout all wings in SAC (22). A weakness of the evaluation procedure is that since the exercise occurs on an active military base; therefore, it is impossible to control the exercise's environment. The environment facing one SPS may be different from the environment another SPS contends with during their evaluation. Some examples of such situational factors might include rush hour traffic on a base, or actual security situations such as a robbery or a traffic accident which must be dealt with immediately. To prevent such events from damaging the performance rating the SPS receives, the evaluator can discontinue the evaluation if in his opinion, an actual security contengency on base precludes a fair evaluation (22).

Data Collection and Processing

Data for SPS law enforcement performance on MARE evaluations was obtained from the SAC IG security police evaluation team at Headquarters SAC, Offutt AFB in Nebraska. The data was copied from the records of the SPS evaluation team. The data was listed by base with the results of the MARE divided into three subtasks: 1) correct and timely response to the accident, 2) establishment of a cordon and containment of the accident, and 3) evacuation of personnel from the accident site. The three subtasks were combined and the average was used as the score for each unit's performance of the MARE. The data collected was for 1984 SAC IG evaluations.

Data for missile maintenance team performance during SMES evaluations was obtained from the 3901 SMES records branch at Vandenburg AFB, in California. For each annual missile wing evaluation, pass rates for each division within the maintenance organization were recorded. These individual pass rates were used as input data for performance scores for missile maintenance teams. The data collected from 3901 SMES was for all missile maintenance team inspections during 1981, 1982, and 1983. Three years were used in order to generate a normal sampling. Sampling only one year was not sufficient since only six Minuteman missile bases are evaluated each year.

The temperature at the time of the evaluation was not recorded by the evaluators. Consequently, this information had to be found independently from evaluation records. To do this, the date of the evaluation was noted and then the average daily temperature for the location of the evaluation was found using weather information provided by the National Weather Bureau. If the evaluation took place over more than one day, the average of the daily temperatures was used. The windchill factor was calculated by noting the average wind speed for the area on the day of evaluation. For evaluations spanning more than one day, wind speed was averaged.

Data Assumptions. It is assumed that average daily temperatures and wind speeds closely reflect the actual temperature and wind speed at the time of task performance. It is also assumed that the data does not contain evaluator bias and that the standards for determining task performance scores are uniformly applied by all evaluators.

Simple Linear Regression

The purpose of simple linear regression is to test the strength of the relationship between an independent variable and a dependent variable (25:396). An independent variable is a controlled variable which is established on the basis of predetermined constraints by the researcher, while the dependent variable responds to the values that the independent variable assumes (25:397). Simple linear regression attempts to construct a model which predicts the response of the dependent variable as the values for the independent variable change (25:396-7). The general form of the model will be y = (deterministic component) + random error component (25:397).

Specifically, a simple linear (straight line) relationship is represented by the following equation:

$$Y = B_0 + (B_1 * X) + E \qquad (25:397) \qquad (1)$$

where

Y = dependent variable
X = independent variable
B_0 = point at which the line represented by the equation intercepts the y axis
B_1 = the slope of the line which expresses the nature of the relationship between x and y
E = random error component

The random error component is used to quantify the unex-plained variations of the dependent variable, (i.e., those variations not attributable to the independent variable (25:396)). Examples of such variations not attributable to temperature might include the level of training received by individuals, experience and skill levels, repair equipment operation, etc. The random error component will not determine how strongly one such particular variation is, but rather how strongly all variations in combination (and not attributable to the independent variable) influence the dependent variable.

The values for x in the model will the temperatures recorded at the time and place of the evaluations while the values for y will be the performance ratings received by the organizations from their respective evaluators. The values for Bo, B1, and E will be determined by using a computer statistical package to fit the data to a hypothesized line. Once a line has been hypothesized to be a model of the relationship between the x and y variables, a confidence interval will be determined to establish the degree of certainty that the model does, in fact, represent reality.

To determine the strength of the correlation between the dependent and independent variables, the Pearson product moment correlation coefficient, r, will be used. This coefficient "provides a quantitative measure of the strength of the linear relationship between the values of x and y"

(25:418). The value of r will always assume a point within the interval between -1 and +1 (25:418). The value of r can be calculated automatically using a computer statistical package given values for x and y. r is calculated by the computer using the formula

$$R = \frac{SSxy}{(SSxx * SSyy) ^{**}1/2} \quad (2)$$

where

SSxx = the standard variance of all values for x
SSyy = the standard variance of all values for y
SSxy = the standard variance for the differences between each paired value for x and y

Note: the formulas for computing SSxy, SSxx, and SSyy are given in Appendix A.

A value of r approaching 0, implies little or no correlation between x and y (25:418). A value of -1 means that as x increases, y decreases; similarly, a value of +1 implies that as x increases, y increases (25:418). It must be noted that values of exactly +1, 0, or -1 are most unlikely, since these values imply a perfect positive relationship, absolute independence, or a perfect inverse relationship (25:418). Such relationships are rare in actuality.

<u>Determining Significance of Results</u>

Once the strength of correlation has been determined, it is desirable to establish the level of certainty for which each model is correct. This is done by developing an interval or range in which there is a 95% certainty that the true value for "B1" from Equation (1) is actually contained. Large ranges indicate weak confidence that the computed value of "B1" found is accurate. The smaller the confidence range's size, the greater the probability that the real value of "B1" is very close to the value arrived at using Equation (1). The equation used to establish a confidence interval for the model's ability to predict the value of y given a value of x will be of the form:

$$B1 +/- (t * sB1) \qquad (3)$$

where

B1 = computed value from Equation (1)
t = statistical test for small samples (25:414)
sB1 = s / (SSxx)**1/2
s = standard deviation of all x values
SSxx = sum of all squared values for x - sum of all squared values of x divided by the number of x vaules considered

Methodology Assumptions. In order for confidence intervals to be established for the correlations some assumptions regarding the input data must be made. The following assumptions are made regarding the random error component for the input data, "E": 1) "the random error component is distributed normally with a mean equal to zero and and with a variance equal to the square of the standard deviation" (25:458), 2) "the random errors are independent of each other" (25:458). It is assumed that the data used in this research will generate a random error component which is normally distributed. This assumption is based on the fact that for every given variance outside the independent variable there will be a large enough population sample to imply normality, and that the generated regression model has a strong correlation between the variables X and Y (25:458). The Central Limit Theorem states that as the sample size becomes larger, the more the population tends to become normal (25:254). Furthermore, the Central Limit Theorem states that if "a random sample of n observations is selected from a normal population, the sampling distribution of the mean will be normal" and therefore the random error component E should be normal (25:254). However, to determine if the population sample's random error component is in fact normal, a box plot will be constructed (See Figure 5).

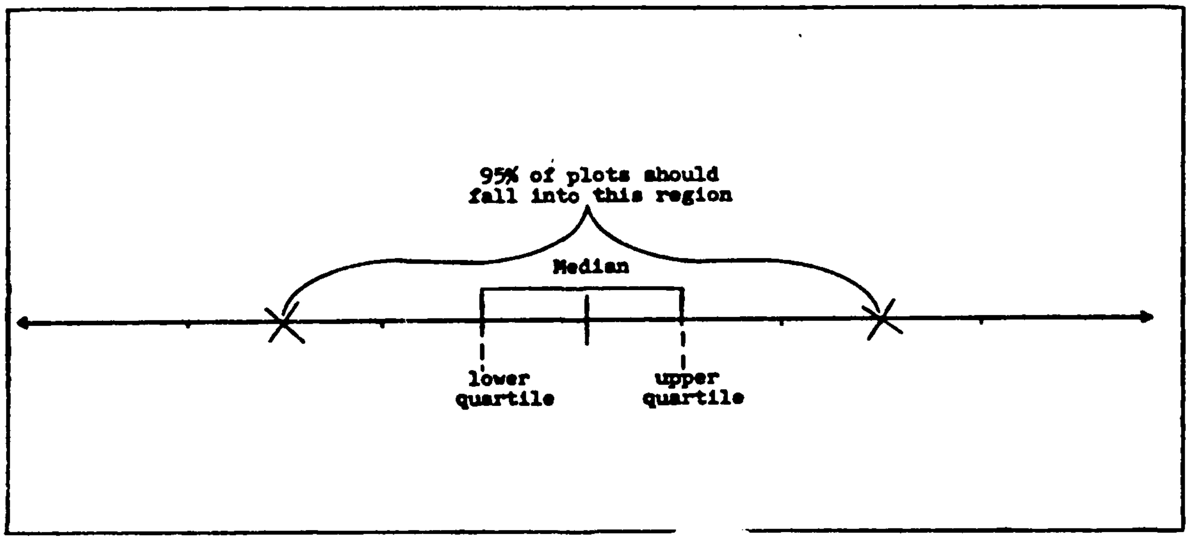

Figure 5. Box Plot for Establishing Random Error Normality

This is accomplished by "examining the distribution of the differences between the observed and predicted values of y" (25:452). This requires ordering the differences in ascending order by plotting the points on a horizontal axis (25:452). Next, the median value is located after which upper and lower quartiles are located so that 75% of all values are above the lower quartile and 75% of all values are located below the upper quartile. The result should be that 50% of all values are located between the boundaries of the two quartiles. The distance between the two quartiles is measured and then marked off on the horizontal axis that same distance in both directions from the median (25:452). An "X" will be used to denote the distance marked off in either direction. "If the total number of values falling between the two Xs is approximately 95%, then the random error component is assumed to be normal, while if the number of values not falling in this range substantially deviates from 5%, there is strong evidence to believe that the distribution is not normal" (25:452). However, it must be noted that as the regression model's value for B1 approaches 0, the random error component may become larger and if one or more intervening variables are present, then E will become less normal. This is expected since the relationship between the intervening variables and Y causes the random error components to lose independence. This being the case, the regression model has little value in predicting Y given X.

The data used for inputs for the values of X and Y must be continuous. Continuous variables are those points which can assume any value within a given interval (25:155). Example: within the interval 1 to 2 there are an infinite number of points such as 1.99999 or 1.2345678, etc. The data used for testing the hypothesis here will be continuous since any value between 0 and 4 is possible regarding the evaluation scores for the SPS, and any value between 0 and 100 is possible for the maintenance squadrons. (Note: the values of X and Y will be rounded off to two significant digits, i.e., 2.23 or 40.98).

Experimental Design

The research objectives requiring determination of the relationship between performance and temperature and the strength of any correlation will be answered using the simple linear regression model. The data used in this model will be displayed in tabular form. Input data is displayed in Appendix B for the security police model and Appendix C for the missile maintenance model. The data used for inputs into the regression model for both security police and missile maintenance organizations will be labeled as X, Xc, and Y. For the security police model, the independent variable, X, is the temperature at the time of the evaluation of the MARE, while Xc is the temperature with the wind chill factor included. The dependent variable, Y, is the rating received for performance of the MARE with 0 being the lowest and 4 being the highest score possible. Once the input data is computed using Equations (1) and (2), the results will be provided listing the strength of the correlation and a suggested model for the correlation. Table I provides a sample of the display of results from the regression model.

TABLE I

Regression Model Results (Sample)

```
          **********Temperature vs Performance Rating***********
                             (no windchill)

CORRELATION STRENGTH "R" = ??
SUGGESTED MODEL     Y = Bo + B1 * X + E  (where the values
                                  for Bo, B1, E are given)

          **********Temperature vs Performance Rating***********
                           (windchill included)

CORRELATION STRENGTH "R" = ??
SUGGESTED MODEL     Y = Bo + B1 * X + E  (where the values
                              for Bo, B1, and E are given)
```

Similarly, missile maintenance input data (See Appendix C) will be displayed with the independent variable, X, being the temperature at the time of the task performance, Xc is the temperature including the wind chill factor, while the dependent variable, Y, represents the score received for the performance. As noted earlier, enough inputs are not available for each maintenance unit to ensure normality of data; consequently, the data will be displayed and computed as a whole for all maintenance teams by combining all the individual team results into one composite. The missile maintenance results from the regression model will be displayed in the same format as displayed in Table I.

Confidence interval display will be based on Equation (3). Table II provides a sample of how the confidence intervals for each regression model will be displayed.

TABLE II

Confidence Interval Display (Sample)

t = 1.717   N = 23 with N-1 degrees of freedom at a 95% confidence range

sB1 = .0059

B1 = .000357

Confidence interval = .000357 +/- 1.717 * .0059   (3)

= .0139 to -.009 (the interval's range)

Again, the purpose of the confidence interval is to provide a range in which there is a 95% probability that the true value for the model lies inside that range.

Summary

The rationalization for the methodology used to test the hypothesis has been presented. Because the effect of one variable, temperature, will be tested against a single dependent variable, performance, simple linear regression was selected. Using missile maintenance and security law enforcement units as the sample population base was justified because both units work in cold temperature environments and perform standard duties which are regularly evaluated. Also, the missile maintenance units will supply data regarding performance of technical tasks in cold temperatures while the security units will provide data for nontechnical task performance. Finally, the assumptions and limitations of the methodology were reviewed. Since normal distribution of the random error component is a fundamental assump-tion necessary for the validity of simple linear regression models, special emphasis was given to the procedure for determining if the population sample's random error component was normally distributed and when this determination is invalid.

III. Results

Overview

The temperature and performance results from the SAC IG inspections of security police squadrons were analyzed for cor-relation using the simple linear regression model reviewed in Chapter II. Likewise, the temperature and performance results of missile maintenance squadrons evaluated by the 3901 SMES were analyzed and the correlation noted. After the strength of the correlation (using Equation (2) to obtain Pearson's product moment correlation coefficient, "R") was noted for both the security police and missile maintenance organizations, their respective models are given based on Equation (1). The test for normality of the random error component is performed for each model with an explanation of results. Finally, the significance or reliabi ity of the model was formed by developing a confidence interval (Equation (3)) for "B1".

Input Data

Appendix B lists the input data for the security police squadrons. The variable "X", or "Xc" represents the independent variable, temperature; while "Y" denotes the dependent variable, performance rating. Marginal or failure ratings are listed in parentheses beside the numerical rating where applicable. Note: the name and date of the unit evaluated is not associated with performance rating recieved. Association of this information is restricted by direction of the SAC IG. This policy applies to both the security police and missile maintenance units. Appendix C displays the input data respectively for the missile maintenance model.

Results

The correlation between temperature and performance for security police squadrons was found to be 0.00658 as indicated by Pearson's product moment correlation coefficient, "R" (See Table III).

TABLE III

Security Police Results

**********Temperature vs Performance Rating**********
(no windchill)

CORRELATION STRENGTH "R" = .00658

SUGGESTED MODEL Y = 1.903 + (0.0023 * X) + .554

**********Temperature vs Performance Rating***********
(windchill included)

CORRELATION STRENGTH "R" = .00377

SUGGESTED MODEL Y = 1.940 + (.0016 * X) + .554

Since the value of "R" is so close to zero, there is no correlation suggested between temperature and performance. While a value of .25 or less suggests that little correlation exists, a value of .00658 is a strong indication of independence between the two test variables X and Y. Since B1 is 0.00233, the value for X, the temperature, will tend towards zero thus eliminating it as an input determining the value for Y. Because X has little predictive utility, the random error component should be large relative to Bo. As expected, E = .5534 which is over 25% the size of Bo. Furthermore, Y must depend upon some other factor which is unaccounted for in the model. The large random error component suggests this fact. However, using a box plot (See Figure 5), it can be determined if the random error component is normal. Figure 6 displays the results of the box plot and reveals random error component deviation of 08%. The deviation should not exceed 05%; consequently, the random error component is suspected not to be normal and a relationship between the components may exist. Such a correlation suggests that one or more unaccounted for variables are influencing Y's value.

When the windchill factor was included in the model, the results were similar. The correlation strength was very low at .0063 which again causes the input value Xc to tend to 0. A box plot (See Figure 6) constructed for the random error component reveals a 15% deviation. This is even

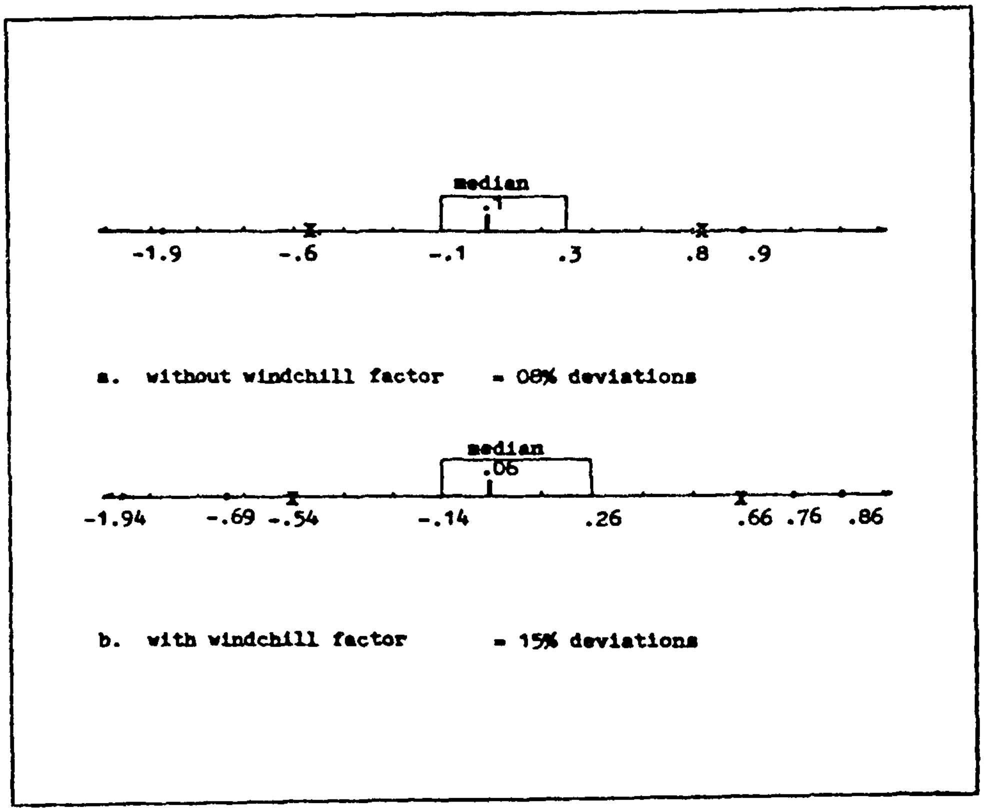

Figure 6. Box Plot for Random Error Component for Security Police Regression Models

stronger evidence that other, unaccounted for variables are influencing the values Y assumes.

The results of the regression model analysis on missile maintenance data is similar to the results for the security police units. For the model without consideration for the windchill factor, the correlation coefficient "R" equals .00933 which again is very close to zero and indicates no correlation between temperature and performance rating (See Table IV).

TABLE IV

Missile Maintenance Results

**********Temperature vs Performance Rating********** (no windchill)
CORRELATION STRENGTH "R" = .ØØ933
SUGGESTED MODEL Y = 94.541 - (.Ø37 * X) + 8.346
**********Temperature vs Performance Rating*********** (windchill included)
CORRELATION STRENGTH "R" = .ØØ63
SUGGESTED MODEL Y = 94.Ø39 - (.Ø27 * X) + 8.359

The suggested model coefficient for B1 is -.Ø367 which eliminates the value of X as a determinant for Y. Again, the value for E is very large proportionately to Bo. Figure 7 depicts the box plot for E. Deviations of Ø9% are found in this model indicating that E is not normal and as in the security police model, unaccounted for variables may be influencing Y. When the windchill factor was accounted for in the missile maitenance model, B1 remains very small at -.Ø266 while Bo is 94.Ø4. The box plot for this final model produces Ø9% deviations.

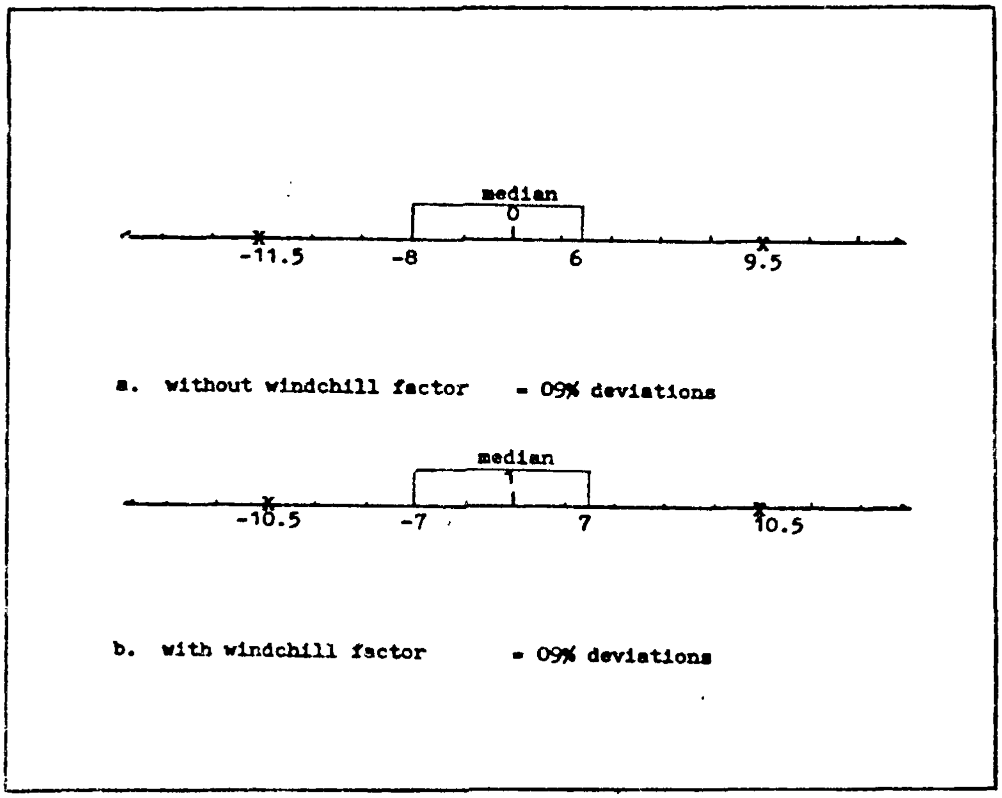

Figure 7. Box Plot for Random Error Component for Missile Maintenance Regression Models

Significance of Results

For each model, the random error component had a deviation of greater than 05% thus indicating that "E" did not have a normal distribution . Therefore, as noted earlier, confidence intervals cannot be formed (25:452). Without a larger sampling of organizations, the probability of how close the computed value of "B1" is to its true value cannot be determined.

Summary

The results for all four models are nearly identical. A very weak correlation was found to exist between performance rating and temperature. This result was unchanged for temperatures including and excluding the wind chill factor. Each model had a value for "B1" which closely approximated zero. This suggests that temperature has negligible influence upon the performance rating received. Confidence intervals could not be formed to establish the significance of the "B1" values computed for each model.

IV. Conclusions and Recommendations

Overview

This chapter begins with a review of the research and purpose of this study as noted in Chapter I. A discussion of the results of this study is followed by a conclusion for each research objective. Finally, recommendation for further research and areas that need further study are suggested.

Research Review

A large portion of Strategic Air Command's forces are located in cold climate environments. Previous research has indicated that cold temperatures can induce stress which in turn reduces mental concentration and increases apathy. Given the importance of sustaining the combat readiness of SAC's nuclear forces, it was decided that the effects of cold temperatures upon the ability of personnel to perform duties in support of these nuclear forces would be studied. As a method of contrasting the effects of cold upon the ability to concentrate on tasks emphasizing thought against tasks more physical in nature, two types of organizations were sampled. Security police law enforcement branches were sampled as representative of nontechnical task performers while missile maintenance teams were sampled as representative of technical task performers.

After using the performance scores given to sampled units by higher headquarter inspectors and the temperatures at the time of the observations, simple linear regression techniques were used to find the relationship between temperature and task performance.

Summary of Results

For each model, confidence intervals for "B1" were not formed because the distribution of the random error component was not found to be normal. This means that the true value for "B1" may in each case be close to zero, but this cannot be substantiated with any level of probability. Assuming that "B1" is close to zero as indicated from the results of Tables III and IV, temperature drops from the model as a factor determining the value for "Y", performance. In addition, since each box plot for E reveals a significant deviation from the normal maximum of Ø5%, a correlation between random error components may exist. Since the model used in this research was based on simple linear regression with temperature being the only independent variable used, the effects of other variables were not considered. This accounts for the large values "E" assumed in each model and the corresponding lack of normality. Nevertheless, because Pearson's coefficient in each case was nearly zero and "B1" tended towards zero in all models, there is evidence that the relationship between temperature and performance was negligible. Consequently, there is no evidence to indicate that the temperatures experienced by the organizations sampled played a significant role in determining the performance rating they received.

Conclusions

Research Objective #1. The relationship between an organ-ization's performance of nontechnical tasks and the temperature at the time of the performance was found to be insignificant for the population sampled. This insignificant correlation was found to exist regardless of whether or not the wind chill factor was added.

Research Objective #2. The relationship between performance of organizations completing technical tasks and temperature was also found to be insignificant. Consideration of the wind chill factor did not affect this conclusion. Prior research concerning cold temperature and human mental ability suggested that performance would be degraded. Since this was not the case, a number of possible explanations arise. First, the evaluators considered the cold a factor and subjectively compensated for this by grading task performance more favorably for organizations operating in cold conditions. Second, the temperatures experienced by the population sampled were not cold enough to influence mental behavior. Third, those sampled were not exposed to the cold long enough to feel the full effects of the temperature.

The first explanation is possible; however, all evaluators interviewed adamately denied evaluator bias due to cold temperature. For this reason, it is assumed that evaluator bias did not play a significant role in the results obtained. The second explanation is a likely possibility since the lowest temperature experienced during the sampled tasks was -2 degrees (-10 degrees with wind chill factor included). The previously noted Soviet experiments with cold temperature environments occured at much lower temperatures of -50 degrees and below (5:151). Also, the length of these exposures varied with temperature. As such, the colder the temperature, the less time was needed for the effects of the cold to occur (5:151). The temperatures experienced and the length of time exposed to the cold were not paired so as to produce significant results for the populations sampled in this research.

Research Objective #3. Since Pearson's Correlation Coefficient "R" was found to be very close to zero, the relationship between the two variables "X" and "Y" was weak for each model. A value for "R" of .25 or less would suggest a weak correlation between variables. The values for "R" noted in this reasearch ranged from a high of .006 to a low of .009. Therefore "R" strongly implies no relationship between temperature and performance for the sampled organizations. This suggests that organizational performance was not adversely affected by the temperatures experienced during the evaluations. If evaluator bias did not bolster the scores received by those units observed during cold temperatures, then future evaluations and inspections need not avoid or delay performance observations due to the range of cold temperatures studied in this paper. If it is assumed that the evaluations by the SAC IG and 3901 SMEs occurred during representative climatic conditions for each base, then the cold weather climates have negligible affect upon missile maintenance and security police operations. Also, while previous research indicates that colder temperatures may adversely affect specific individuals during task performance, organizational performance is not affected.

Recommendations

Several areas for further research are suggested in conjunction with this study. The temperatures noted for the organizations dropped below zero only once. As such, no conclusion can be made with regard to how sub-zero temperatures affect organizational performance. Also, the length of exposure to the cold was short ranging from 30 minutes to several hours (3). Therefore, it is not known at what point in time or temperature performance begins to degrade. This unknown point needs to be established for both technical and nontechnical tasks. Research in this area could help determine at what point temperature becomes a factor in determining performance. Further research examining the effects of prolonged exposure to cold temperatures should be evaluated with respect to performance. Additional research could be performed to determine if different measures of performance are influenced by cold temperatures. Such measures might include task completion times, accident rates, or morale considerations.

With the activation of the Air Force's new Ground Launch Cruise Missile (GLCM) systems in Europe, prolonged exposure to cold temperatures may become an important factor since missile crews deploy with the system and live in the field for days at a time. Since missile maintenance will be performed on the GLCM system in the field (3), accurate data concerning technical task performance in cold temperature environments can help define operational limitations and supplement deficient areas of maintenance planning. Also, security personnel are deployed with each GLCM in the field. The impact upon their performance in cold field conditions requires study. Because security personnel safeguard the system from hostile threats, their reliable performance even in cold temperatures is imperative in maintaining GLCM readiness. In this respect, research investigating the effects of cold on missile security and aircraft security personnel's ability to detect and counteract hostile events could provide insight into how to better protect GLCM systems. If prolonged exposure to cold temperatures reduces security personnel effectiveness, then action will be needed to compensate for this problem.

Appendix A: Computation Formulas for Pearson's "R" Coefficient

$$R = \frac{SSxy}{(SSxx * SSyy)^{1/2}}$$

$$SSxx = \text{Sum of all } (Xi)^2 - \frac{\text{Square of all } (Xi)^2}{N}$$

$$SSyy = \text{Sum of all } (Yi)^2 - \frac{\text{Square of all } (Yi)^2}{N}$$

$$SSxy = \text{Sum of all } (Xi * Yi) - \frac{\text{Sum of all } Xi * \text{Sum all } Yi}{N}$$

Appendix B: Security Police Data

X (Temperature)	Xc (Temperature) "wind chill"	Y (Performance Rating)
57	57	2.50
52	52	2.75
35	30	2.50
37	37	2.20
46	46	2.25
33	29	2.00
28	22	2.20
43	43	0.00 (Failure)
77	77	2.00
49	49	1.25 (Marginal)
67	67	2.00
55	55	1.80 (Marginal)
65	65	2.20
86	86	2.00
70	70	2.80
50	50	1.75 (Marginal)
53	53	2.25
-1	-1	2.00
43	43	2.00
44	44	2.20
44	44	2.00
69	69	1.85 (Marginal)
25	10	2.00

Appendix C: Missile Maintenance Data

X (Temperature)	Xc (Temperature) "wind chill"	Y (Performance Rating)
**************	Base Results	**************
68	68	87.3
68	68	100.0
68	68	92.0
68	68	85.0
68	68	73.3
68	68	100.0
68	68	53.3
**************	Base Results	**************
67	67	92.7
67	67	100.0
67	67	95.4
67	67	77.5
67	67	86.7
67	67	100.0
67	67	80.0
**************	Base Results	**************
29	25	96.4
29	25	96.9
29	25	96.6
29	25	88.3
29	25	93.3
29	25	100.0
29	25	88.2
**************	Base Results	**************
39	39	100.0
39	39	100.0
39	39	100.0
39	39	86.6
39	39	100.0
39	39	100.0
39	39	72.0
**************	Base Results	**************
21	21	98.2
21	21	96.9
21	21	97.7
21	21	93.3
21	21	100.0
21	21	100.0
21	21	73.3

X (Temperature)	Xc (Temperature) "wind chill"	Y (Performance Rating)
************** Base Results **************		
20	15	94.5
20	15	90.6
20	15	100.0
20	15	100.0
20	15	86.7
20	15	86.6
20	15	93.1
************** Base Results **************		
38	38	94.5
38	38	100.0
38	38	100.0
38	38	100.0
38	38	86.7
38	38	96.7
38	38	96.6
************** Base Results **************		
-2	-10	94.5
-2	-10	100.0
-2	-10	96.5
-2	-10	88.3
-2	-10	80.0
-2	-10	100.0
-2	-10	93.3
************** Base Results **************		
28	24	87.2
28	24	87.5
28	24	87.3
28	24	96.6
28	24	96.6
28	24	100.0
28	24	93.3
************** Base Results **************		
67	67	90.0
67	67	100.0
67	67	94.3
67	67	80.0
67	67	93.3
67	67	100.0
67	67	93.3

X (Temperature)	Xc (Temperature) "wind chill"	Y (Performance Rating)
************** Base Results ***************		
20	15	94.5
20	15	90.6
20	15	100.0
20	15	100.0
20	15	86.7
20	15	86.6
20	15	93.1
************** Base Results ***************		
38	38	94.5
38	38	100.0
38	38	100.0
38	38	100.0
38	38	86.7
38	38	96.7
38	38	96.6
************** Base Results ***************		
-2	-10	94.5
-2	-10	100.0
-2	-10	96.5
-2	-10	88.3
-2	-10	80.0
-2	-10	100.0
-2	-10	93.3
************** Base Results ***************		
28	24	87.2
28	24	87.5
28	24	87.3
28	24	96.6
28	24	96.6
28	24	100.0
28	24	93.3
************** Base Results ***************		
67	67	90.0
67	67	100.0
67	67	94.3
67	67	80.0
67	67	93.3
67	67	100.0
67	67	93.3

X (Temperature)	Xc (Temperature) "wind chill"	Y (Performance Rating)
************** Base	Results ***************	
71	71	96.4
71	71	100.0
71	71	97.7
71	71	97.5
71	71	86.7
71	71	100.0
71	71	86.7
************** Base	Results ***************	
21	10	87.3
21	10	81.3
21	10	85.1
21	10	86.7
21	10	93.3
21	10	100.0
21	10	73.3
************** Base	Results ***************	
62	62	94.5
62	62	87.5
62	62	92.0
62	62	100.0
62	62	86.7
62	62	100.0
62	62	93.3
************** Base	Results ***************	
74	74	89.1
74	74	100.0
74	74	93.1
74	74	95.0
74	74	93.3
74	74	100.0
74	74	60.0
************** Base	Results ***************	
50	50	87.3
50	50	96.9
50	50	90.8
50	50	96.8
50	50	100.0
50	50	100.0
50	50	93.8

X (Temperature)	Xc (Temperature) "wind chill"	Y (Performance Rating)
************** Base Results ***************		
29	25	98.2
29	25	100.0
29	25	98.9
29	25	100.0
29	25	100.0
29	25	100.0
29	25	100.0
************** Base Results ***************		
28	15	94.5
28	15	97.0
28	15	95.5
28	15	96.7
28	15	100.0
28	15	100.0
28	15	75.0
************** Base Results ***************		
60	60	94.5
60	60	100.0
60	60	96.6
60	60	93.3
60	60	86.7
60	60	100.0
60	60	86.7

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This investigation determined the effect of cold temperature variations on the performance of security police and missile maintenance organizations within Strategic Air Command (SAC). The security police performance measurement was based on the rating given to each organization by the SAC Inspector General observing the execution of a Major Accident Response Exercise (MARE). Missile maintenance performance was based on the rating the organization received from the annual Strategic Missile Evaluation Squadron (SMES) inspection. The missile maintenance organization was observed performing routine maintenance tasks. For each security police and missile maintenance performance rating, the temperature at the time of the observation was obtained from the National Weather Service.

Simple linear regression was used to determine the strength of correlation between the temperature at the time of the evaluation and the performance rating received. By using simple linear regression it was possible to determine if performance declined as the temperature became colder. The results of this investigation revealed that no correlation existed between the observed temperatures and the performance ratings received by the sampled units. Keywords: Cold Weather Operations, Cold Stress, Performance (Human), Stress (Physiology).

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